Synopsis V1.0
Single Event Transient and Destructive Testing of the
Texas Instrument SN54LVT16245B Octal Buffer/Driver With 3-State Outputs

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I. Introduction

This study was undertaken to determine the single event destructive and transient susceptibility of the SN54LVT16245B Bus Transceiver. The device was monitored for transient interruptions in the output signal and for destructive events induced by exposing it to a heavy ion beam at the Texas A&M University Cyclotron Single Event Effects Test Facility.

II. Devices Tested

The sample size of the testing was two devices. The devices were manufactured by Texas Instruments and were characterized prior to exposure. The devices tested had a Lot Date Code of 0302.

III. Test Facility

Facility: Texas A&M University Cyclotron Single Event Effects Test Facility, 15 MeV/amu tune.
Flux: 5.3×10^4 to 1.5×10^5 particles/cm^2/s.

Ion	LET (MeVcm^2/mg)
Ar	8.57
Cu	20.7
Xe	53.1

IV. Test Methods

The SN54LVT16245B was tested with heavy ions. The basic block diagram showing the test configuration is shown in Figure 1 and the SN54LVT16245B test circuit is shown in Figure 2. The Test Setup for the SN54LVT16245B latch up and transient experiment consisted of a multi-channel power supply and a digitizing oscilloscope. Control of all test equipment was performed remotely via General Purpose Interface Bus (GPIB) with a Laptop computer as master. The devices on the test board (see Figure 2) consisted of a 74LS136 OR Gate, two SN54LVT16245B (devices under test) and two 74LS85 comparators. All relevant equipment connections to the SN54LVT16245B test board were made using scope probes.

A 74LS136 Exclusive OR Gate (see Figure 2) was used to provide inputs to the SN54LVT16245B because it allows the test engineer to change the inputs simultaneously using one select line. This is necessary because the outputs of the SN54LVT16245B can "hang up" due to the heavy ions, in that situation, the inputs to the SN54LVT16245B can be change remotely by sending a positive edge pulse to produce a "soft reset" to the device. If the soft reset does not work, then power to the SN54LVT16245B can be recycled to reset the device. The outputs of the SN54LVT16245B never "hanged up" during testing so the soft reset circuit was never used.

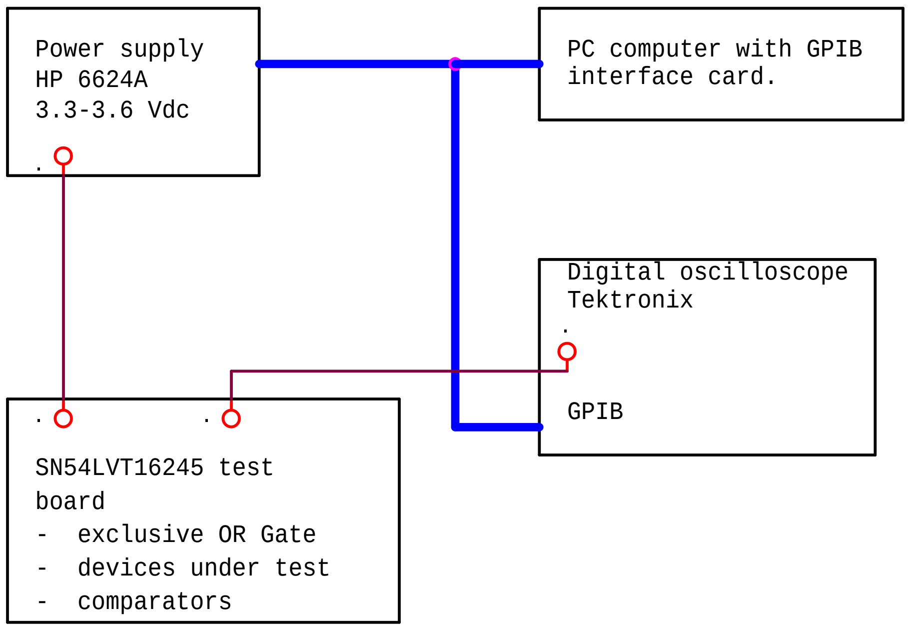

Figure 1. Block diagram for the test configuration for the SN64BCT126A.

Two 74LS85 comparators, which compares two four bit binary numbers, were used to monitor the outputs of the two SN54LVT16245B. The P0, P1, P2, P3 inputs (see Figure 2) of the comparators were connected to the outputs of the two SN54LVT16245B which is then compared to the Q0, Q1, Q2 and Q3 inputs of the comparators. The P=Q output of the comparators are a logic high when the P and the Q inputs are the same (e.g., no errors) and goes low when the inputs are different (e.g., error). The advantage derived from using a comparator is that all four outputs of the SN54LVT16245B can be monitored at once with different input settings, which in our case is High, Low, High and Low.

The P=Q high outputs are monitored via channel 1 and channel two of the digital scope and the output voltage threshold was set at 0.25 to 0.3 volts below the monitored output. Throughout the experiment, only one P=Q output is monitored at a time. In the event of a transient, the P=Q high output would go low which will then trigger the set output voltage threshold. The output will then be captured and downloaded into the laptop computer via GPIB.

The voltage setting used for the output voltage threshold consisted of two different voltage levels. The reason for this is because the two comparators used have different P=Q high outputs. Comparator 1, which was used for DUT 1, has an output level of 4.7 volts with a set output voltage threshold of 4.5 volts. Comparator 2, which was used for DUT 2, has an output level of

4.5 volts with a set output voltage threshold of 4.2 volts. The delta was set to the lowest value where noise did not trigger events.

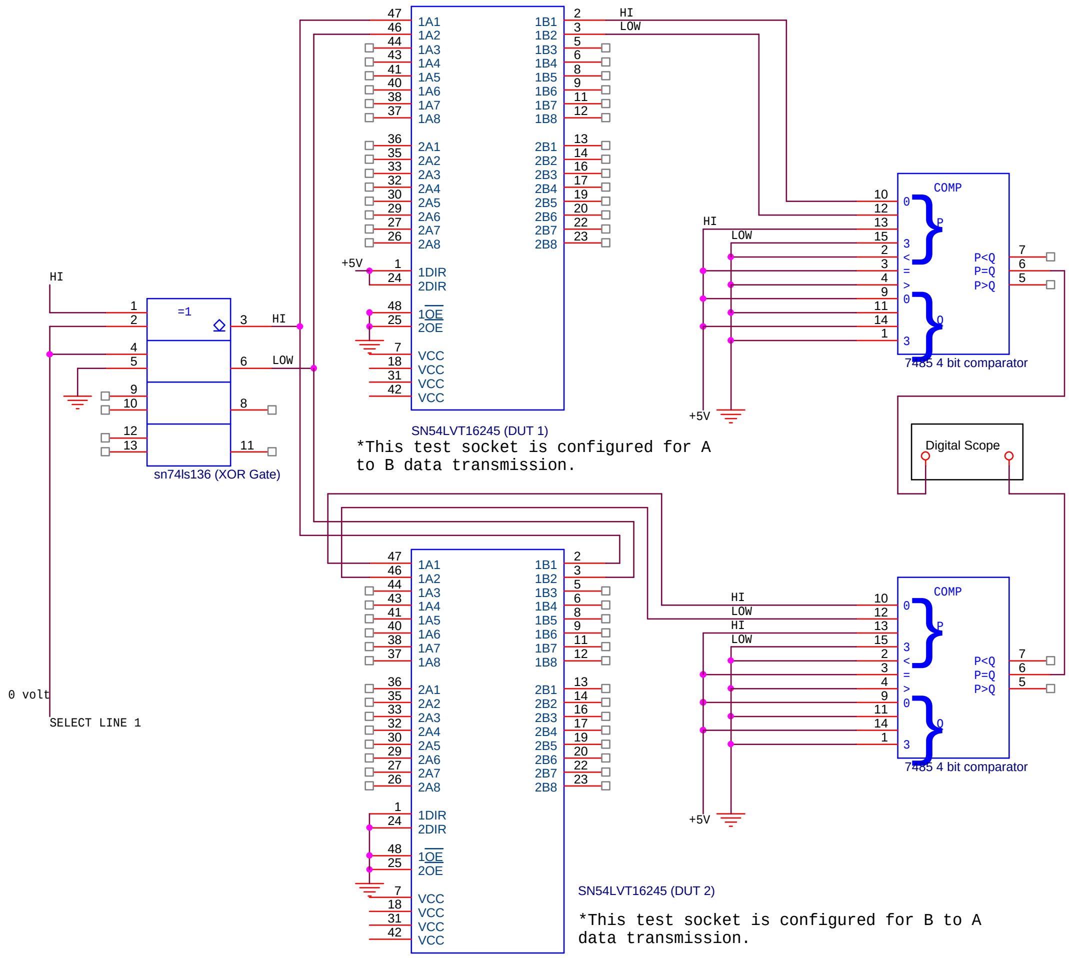

Figure 2. Schematic Diagram for the SN54LVT16245B.

During the experiment, the SN54LVT16245B was tested with the voltage supply to the device set at 3.3 volts. Latch up for the device under test was monitored by setting the power supply current limit to 80mA. If at any point the device starts to draw more than 80mA then the power supply will shut down automatically. The set power supply current limit was never exceeded during testing.

V. Results

During testing the two SN54LVT16245B were irradiated with the Ar beam at both normal incidence and at 45 degrees (yielding an effective LET of approximately 8.7 MeV-cm^2/mg and 12.3 MeV-cm^2/mg). Then the parts were also irradiated with the Cu and then Xe beams at normal and 45 degrees incidence (yielding an effective LETs of approximately 20.7, 29.3, 53.9, and 76.2 MeV-cm^2/mg). Testing was done for both parts with input voltages set to 3.3 volts. Transients from the SN54LVT16245B were only encountered with the Xe beam.

The two SN54LVT16245B Bus Transceivers were tested to measure the latchup cross section under the above conditions. Each part was place in the beam until a latch event occurred or 10^7 ions/cm^2 – the beam fluence was then recorded. During our experiment, no latchup event occurred, yielding a threshold LET for latchup > 76.2 MeV-cm^2/mg.

The two SN54LVT16245B Octal Buffer/Driver Gates were also tested to measure the transient cross section under the above conditions. Each part was place in the beam until transient events occurred or 10^7 ions/cm^2 was reached. If many transients are present then a hundred samples are acquired and then the beam fluence was recorded. During our experiment, transient events occurred.

An average cross section was determined for a given LET as the number of transient events observed divided by the total fluence of all the runs at that LET. The cross section results are presented in Figure 3. A Weibull fit to the data gives an LET threshold for transient of approximately 5 MeV-cm^2/mg and a saturation cross section is approximately 7.0 x 10^{-5} cm^2.

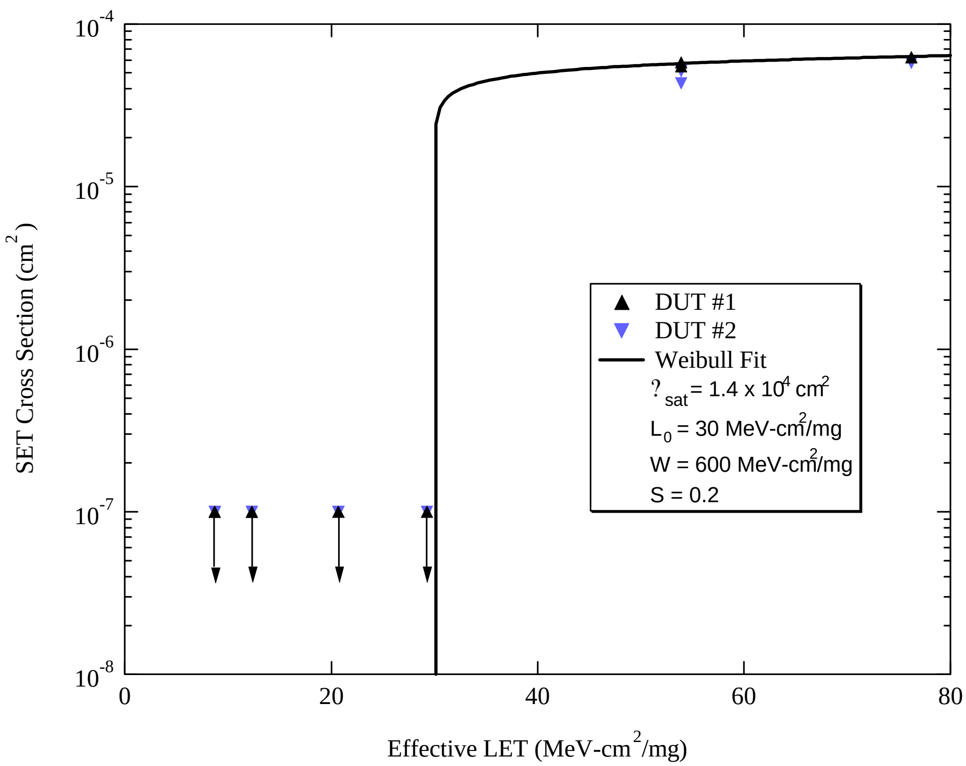

Figure 3. Transient cross section as a function of the effective LET for the SN54LVT16245B Bus Transceiver. The curve shows an approximate threshold of 30 MeV-cm^2/mg and a saturation cross section of greater that 10^{-4} cm^2.

Figure 4 shows a sample transient encountered during testing. The output captured is from the comparator not from the DUT itself. Lab testing of the comparators concluded that the heights of the transients from the comparators are directly related to the pulse width of the transients from the DUT itself. Using Figure 4 as an example we can conclude that the transient from the DUT was about 215 ns since the output of the comparator went below 0.8 volts. Figure 5 is also another example of a transient. The pulse width of this transient is about 100 ns.

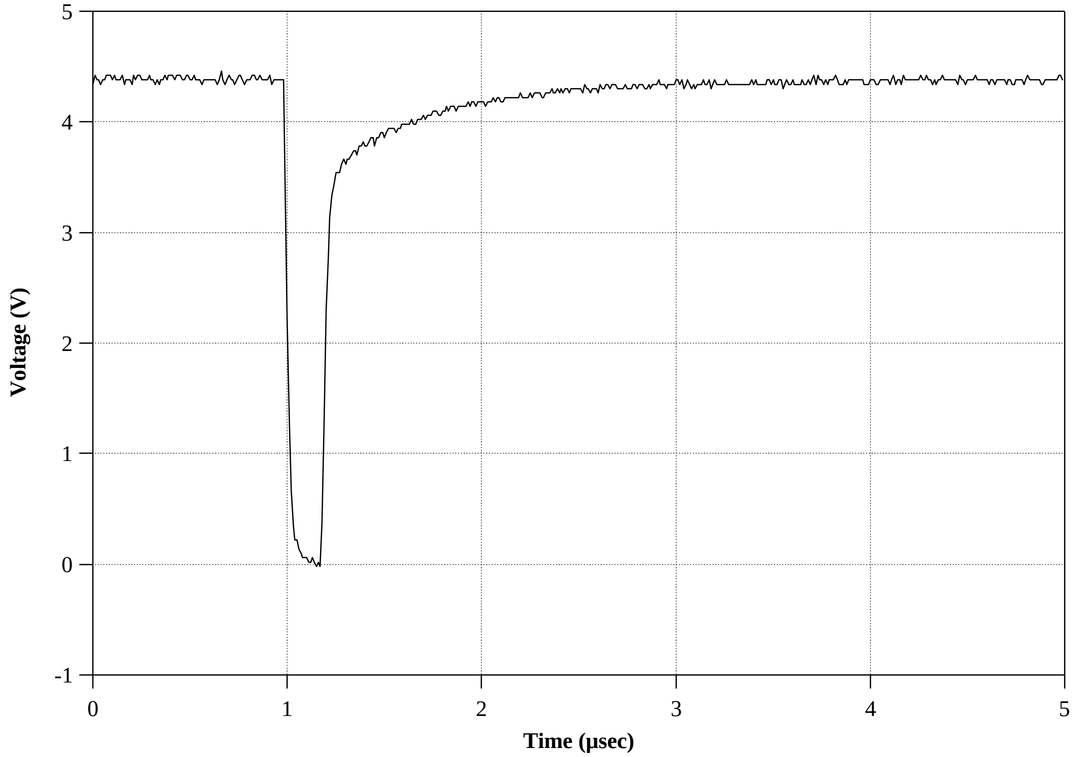

Figure 4. Transient taken from the output of the comparator, which was used to monitor the SN54LVT16245B.

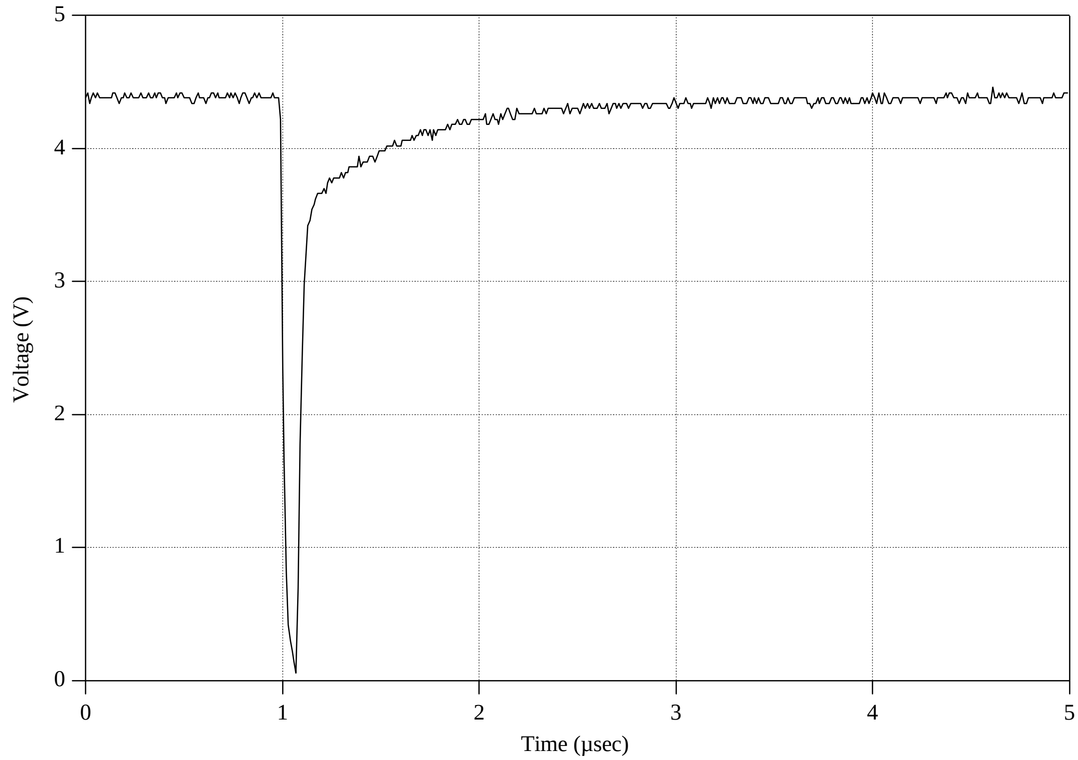

Figure 5. Another transient taken from the output of the comparator

Since the heights of the transients stemming from the DUTs were not monitored during the experiment, we cannot determine the height of the transients by looking at the output of the comparators. But we can assume that voltage levels greater than 3.2 volts were considered high by the comparators and voltage levels below 0.7 volts were considered low (standard for TTL 74LS85 comparators).

Transients like the one in figure 4 and 5 were observed in the different beams use during the experiment. Even though there were transients present in the SN54LVT16245B experiment and that some of the transients were about 215 ns in width, the results were still good because no device latchup occurred, the outputs did not hanged up and there were no destructive failure that resulted from the irradiation of the parts.

VI. Recommendations

In general, devices are categorized based on heavy ion test data into one of the four following categories:

Category 1 – Recommended for usage in all NASA/GSFC spaceflight applications.
Category 2 – Recommended for usage in NASA/GSFC spaceflight applications, but may require mitigation techniques.
Category 3 – Recommended for usage in some NASA/GSFC spaceflight applications, but requires extensive mitigation techniques or hard failure recovery mode.
Category 4 – Not recommended for usage in any NASA/GSFC spaceflight applications.

The SN54LVT16245B Bus Transceivers are Category 2 devices.